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Sensorial Properties of Ice Tea as Affected by Packaging

*Andrej Plestenjak[1], Marjan Simčič[1], Janez Hribar[1], Marjan Veber[2], Andrej Škorja[3], Mira Kordiš-Krapež[4], Peter Pavlič[5] and Rajko Vidrih[1]**

[1] Department of Food Science and Technology, Biotechnical faculty, University of Ljubljana, Jamnikarjeva 101, 1111 Ljubljana, Slovenia

[2] Faculty of Chemistry and Chemical Technology, Aškerčeva 5, 1000 Ljubljana

[3] Laško Brewery, Trubarjeva 28, 3270 Laško, Slovenia

[4] BIA d.o.o. Teslova 30, 1000 Ljubljana, Slovenia

[5] ETOL, Škofja vas 39, 3211 Škofja vas, Slovenia

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Summary

The aim of this research was to determine changes in sensorial properties of ice tea (peach and pear flavoured) filled in polyethylene terephtalate bottles (PET) and tin cans. Bottles and cans were stored at 2 °C and at 20 °C for 12 weeks. Analyses were carried out weekly on tin, iron, aluminum, 5-hydroxymethyl-2-furfuraldehyde (HMF), ascorbic acid and colour intensity. As expected, canned ice tea had higher concentration of tin, iron and aluminum as a result of migration from packaging material. Concentration of metal ions appeared not to be influenced by storage time but depended mainly on the quality of single can. Concentration of HMF, which indicates intensity of heat treatment, increased during storage. HMF and colour intensity (darker colour) were higher in canned ice tea and higher at higher storage temperature in all treatments. Retention of aroma compounds was better in pear flavoured ice tea and always higher in ice tea packed in PET bottles. The level of ascorbic acid decreased during storing with increased temperature. Faster decrease was always observed in ice tea packed in PET bottles. Sensorial properties that dictate the consumer acceptance classified ice tea packed in PET bottles superior compared to those packed in cans.

Key words: ice tea, metal migration, ascorbic acid, HMF, sensory evaluation

Introduction

Packaging material protects the food from spoilage but many interactions between food and packaging material may occur during storage. The quality and shelf life of packed beverages depend on temperature, oxygen concentration (head space and dissolved) as well as on the physico-chemical properties of the packaging material and its interaction with product. Ice tea is susceptible to various deteriorations such as browning, aroma changes and loss of ascorbic acid (*1*). Among factors involved in quality loss are Maillard reaction, loss of ascorbic acid and migration of heavy metals from packaging material (*2*). Traces of metals affect the colour, flavour and shelf life of food (*3*). Corrosion products of steel, primarily iron salts, cause a loss of odour and development of astringent, metallic or bitter taste (*3*). Ascorbic acid is known to act as a ligand of metals.

* Corresponding author; Phone: ++386 (0)1 4231 161; Fax: ++386 (0)1 2566 296; E-mail: rajko.vidrih@bf.uni-lj.si

Heavy metals like copper (II) strongly catalyze the oxidation of ascorbic acid, although other metals like iron, tin and aluminum are also known to catalyze the oxidation of ascorbic acid (*4*). On the other hand, citric acid has the capability to prevent the oxidative reactions mainly by chelating metal ions.

Polyethylene terephtalate (PET) is widely used as packaging material, but it may absorb some aroma compounds from fruit juices (*5*). On the contrary, some aroma compounds from PET may migrate into juice and interact with its contents causing ascorbic acid degradation (*6*). Lemon and orange juices stored in polyethylene or polyprophylene bottles are lower in aroma compounds, such as limonene, than juices stored in glass bottles. Limonene decreases probably because of its oxidation (*6*) or absorbtion. It was found out that within 6 days 40 % of limonene and other aroma volatiles (*7*) and 60 % of terpene (*8*) were absorbed in the polyethylene packaging material. The absorption order of aroma compounds into polymeric packaging materials was terpenes, sesquiterpenes, aldehydes and alcohols (*9*). Polyethylene film provokes an increased rate of browning and a distinct reduction in flavour intensity (*7,10*).

Metal ions are known to change the taste and flavour of canned food. Iron ions are particularly involved in flavour deterioration. They also provoke bitter, astringent and so called metal off-taste (*3*). It is very well-known that high concentrations of iron make food absolutely inedible due to strong colour, taste and flavour alterations (*8*). Metal taste appears when iron concentration is in the range from 10 to 66 ppm, depending on food type (*11*). Tin is used as an inner layer in cans to protect them against corrosion. WHO recommends daily allowance of tin in foods at 3–4 mg/day. Concentrations above 3 g/kg of food are known to be toxic (2). Tin provokes lighter colour of food. Metal taste was detected when tin concentration ranged from 15 to 280 ppm. Tin intake of 4–5 mg/kg of body weight provokes gastrointestinal disorders, while intake of 4–9 mg/kg of body weight provokes acute toxicity *(2)*. Daily intake of aluminum in Europe is 2–5 mg and in USA is 12–40 mg. Aluminum plays no role in biological systems so its intake should be minimized. Aluminum is quite resistant at neutral pH, primarily because of Al_2O_3 protective layer that covers the surface. Al_2O_3 layer prevents further oxidation as well as its migration into solution. Lower or higher pH increases the migration of aluminum into solution. Aluminum is used in manufacturing the covers of the cans. Pasteurized non-carbonated ice tea is a subject of deterioration and quality loss. Nonenzymic browning can be the major cause of colour change and quality loss in citrus juice (*12*) and in food products in general. Degradation of ascorbic acid is in relation with flavour and colour degradation (*13,14*). Increased browning and ascorbic acid degradation may result from increased oxygen permeability of plastic films compared to nonpermeable glass (*15,16*). Evaporation and pasteurization of fruit juices provoke a considerable loss of ascorbic acid when temperature exceeds 60 °C (*15*), while freeze-concentration of fruit juices enables much better retention of ascorbic acid (*1*). Losses of ascorbic acid in reconstituted orange juice packed in plastic-coated cardboard container were up to 2 % per day (*17*). Peach juice browning increased with increased temperature but correlated negatively with increased content of soluble solids (*18*). Aerobic and anaerobic degradation of ascorbic acid occurs in canned, bottled or fiber-bord packed citrus juices (*19*). Single strength orange juice filled in tin-lined cans or glass bottles retains more than 75 % of ascorbic acid after 1 year (*20*). Slightly better retention of ascorbic acid was reported in tin cans (80 %) compared to glass bottles after 6 months of storage (*21*). Ascorbic acid degradation depends on processing parameters, type of packaging material used and handling and storage conditions. Formation of furfural and 5-hydroxymethyl-2-furfuraldehyde usually accompanies degradation of ascorbic acid. Furfural accumulation parallels with non-enzymic browning of orange powder (*22,23*). Furfural accumulation in citrus juice correlates with the storing temperature. Higher storing temperature yields more furfural (*24,25*) while fresh non-pasteurized juice contains no furfural (*24*). A good correlation between furfural accumulation and the appearance of off-flavours was found in citrus juices (*25*). Furfural is thus formed from acid catalyzed ascorbic acid and apparently parallels the formation of off-flavours formed in orange juice (*26*). Usually storage conditions of the orange juice are O_2 content, pH, % Brix, metal ions *etc*. Possibly some other factors can dictate the formation of off-flavours in juice (*26*) as well. HMF formation in apple juice is directly related to the degree of heating (*27*) and its accumulation achieves a plateau after prolonged storage (*28*). A three fold increase of HMF formation in clarified peach juice heated to 108 °C was found when soluble solids content was raised from 30 to 45 % Brix (*18*).

The aim of the work is to evaluate the quality changes of ice tea packed in PET bottles and tin cans during shelf life at 20 °C and 2 °C. Very little or no litterature regarding ice tea was found. Most of the references cited here discuss fruit juices or other beverages packed in cans or PET as is the case of ice tea.

Material and Methods

Sample preparation

Ice tea was prepared from a commercial concentrate (65 °Brix) containing hip-rose extract, citric acid, ascorbic acid, caramel, saccharose and flavoured with naturally identical aroma compounds (Pivovarna Laško). Pear fruit aroma compounds consisted of: hexanal, isoamyl acetate, isoamyl alcohol, hexyl acetate, hexenyl acetate, 1-hexanol, diacetone, hexenol, linalool, citronellyl formate, α-terpineole, α-methyl benzyl acetate, geranyl acetate, ethyl decenoate, ethyl decadienoate, butylated hydroxy toluene, 3-acetin, δ-undecalactone, benzoic acid, 3-ethyl citrate and vanillin. Peach fruit aroma compounds consisted of: butyl acetate, isoamyl acetate, isoamyl alcohol, limonene, *trans* 2-hexanal, hexenyl acetate, 1-hexanol, diacetone, *cis* 3-hexenyl acetate, linalool, α-terpineole, benzyl acetate, damascenone, benzyl alcohol, δ-octalactone, butylated hydroxy toluene, δ-undecalactone, benzoic acid, 3-ethyl citrate, vanillin, benzyl benzoate.

Ice tea was produced in a commercial firm (Pivovarna Laško). The ice tea concentrate was diluted to 8 °Brix, put in cans (aluminum cover, tinned and varnished inner surface) and pasteurized at 75 °C for 15 min. After that, ice tea was immediately cooled by means of water spray to 20 °C. Ice tea in PET bottles was first pasteurised in flow pasteurisator at 90 to 94 °C for 20 sec, immediately cooled to 15 °C and aseptically filled in sterile PET bottles. PET bottles and cans were then stored at 2 and 20 °C in dark for 12 weeks. Determination of ascorbic acid, tin, iron, aluminum, HMF and colour intensity was carried out weekly. Sensory evaluation test was done after 100 days of storage by 5 trained panelists according to Buxbaum method (*29*).

Determination of ascorbic acid

Ascorbic acid was determined according to method described by Kordiš-Krapež *et al.* (*30*). Determination of ascorbic acid was performed by means of HPLC system. Equipped with 4-channel degassing unit, X-act (Jour Research, Sweden); HPLC pump, Maxi Star, K-1000 (Knauer, Germany); Marathon-XT autosampler (Spark-Holland, Holland); UV/VIS detector (Knauer, Germany); Data acquisition system Valuechrom (Bio-Rad, USA).

The following chromatographic conditions were employed: Aminex HPX-87H column (30 cm ×7.8 mm i.d., Bio-Rad, USA) was used. Injection volume was 10 μL, wavelength 245 nm, mobile phase 0.005 M H_2SO_4, (Merck, 95–97 % p.a.) and flow rate 0.5 mL/min. The experiments were done at ambient temperature. The method was linear in the concentration range from 10 to 250 mg/L. Limit of quantification was 1 mg/L. The average relative standard deviation in the concentration range from 10 to 250 mg/L was smaller than 2 %.

Standard and sample preparation

Ice tea samples were injected directly into HPLC system. Ascorbic acid standard (Kemika p.a. min. 99.7 %) solutions were stabilized with (1 %) meta phosphoric acid (Merck p.a.).

Determination of iron, tin and aluminum

Iron, tin and aluminum were determined by electrothermal atomic absorption spectrometry (ETAAS) using Perkin Elmer model 110B atomic absorption spectrometer equipped with HGA 400 graphite furnace and D_2 background corrector *(31,32)*. Perkin Elmer Hollow cathode lamps were used as radiation sources. For graphite furnace measurements pyrolytically coated graphite tubes with L'vov platform were applied. The atomic absorption was measured at 248.3, 309.3 and 286.3 nm for Fe, Al and Sn, respectively. Other instrumental parameters were selected according to the manufacturer's recommendations. Before measurements concentrated HNO_3 (Merck 65 %) was added to samples and standards to final concentrations of 0.2 %. Integrated absorbance measurements were evaluated using calibration curves. The accuracy of the procedure was checked with standard addition technique.

HMF was determined according to the method described by Winkler *(33)*.

Results and Discusion

Soluble solids content of ice tea was 8.0 °Brix, pH value 3.2 and titratable acidity 2.0 g/L expressed as citric acid (Table 1).

Iron concentration increased during storage although it depends on can-to-can variation. Iron migration tended to be lower at storage temperature of 2 °C compared to 20 °C (Table 2), while there was no difference in iron content between peach and pear flavoured ice tea. Ice tea filled in PET bottles contained 5 fold less iron than canned ice tea. Initial content of iron in ice tea originated from stainless steel equipment and containers used during processing. No correlation of iron content and colour intensity was observed.

Content of tin increased during storage although its content depends on can-to-can variation (Table 3). Slightly less tin was found in ice tea stored at 2 °C compared to that stored at 20 °C, suggesting that lower storage temperatures reduce tin migration. As expected, ice tea stored in PET bottles contained no tin, so the only source of tin was packaging material.

Table 1. Composition of ice tea

Sample	Soluble solids (°Brix)	pH	Titratable acidity as citric (g/L)
Pear can	8.00	3.2	2.0
Peach can	8.09	3.2	2.0
Pear PET	8.12	3.2	2.0
Peach PET	8.04	3.2	2.0

Table 2. Mass concentration (γ) of iron in ice tea with the taste of pear or peach packed in cans and stored at 2 and 20 °C; data represent means of 3 replicates $\pm\sigma$

Time (days)	Pear 20 °C (mg/L)	Peach 20 °C (mg/L)	Pear 2 °C (mg/L)	Peach 2 °C (mg/L)
0	0.061 ± 0.006	0.063 ± 0.009	0.061 ± 0.007	0.064 ± 0.006
14	0.045 ± 0.002	0.089 ± 0.008	0.010 ± 0.001	0.063 ± 0.003
30	0.141 ± 0.009	0.122 ± 0.005	0.097 ± 0.007	0.058 ± 0.003
56	0.096 ± 0.007	0.133 ± 0.006	0.075 ± 0.010	0.042 ± 0.005
76	0.295 ± 0.008	0.206 ± 0.001	0.139 ± 0.009	0.093 ± 0.004
100	0.111 ± 0.008	0.209 ± 0.013	0.026 ± 0.002	0.145 ± 0.001

Table 3. Mass concentration (γ) of tin in ice tea with the taste of pear or peach packed in cans and stored at 2 and 20 °C; data represent means of 3 replicates ± σ

Time (days)	Pear 20 °C (mg/L)	Peach 20 °C (mg/L)	Pear 2 °C (mg/L)	Peach 2 °C (mg/L)
0	0.0	0.0	0.0	0.0
14	0.008 ± 0.0004	0.013 ± 0.0001	0.010 ± 0.0007	0.012 ± 0.0009
30	0.007 ± 0.0008	0.004 ± 0.0003	0.000 ± 0.0002	0.003 ± 0.0005
56	0.005 ± 0.0003	0.000 ± 0.0001	0.008 ± 0.0005	0.006 ± 0.0005
76	0.028 ± 0.0009	0.010 ± 0.0009	0.000 ± 0.0002	0.000 ± 0.0001
100	0.024 ± 0.0012	0.013 ± 0.0005	0.005 ± 0.0008	0.012 ± 0.0004

It was found that aluminum started to migrate from aluminum cover at the very beginning of storage of canned ice tea. Less aluminum was found at 2 °C than at 20 °C (Table 4). Ice tea stored in PET bottles contained 10 fold less aluminum compared to ice tea filled and stored in cans. Some aluminum-made equipment obviously caused an increase of aluminum content in ice tea in PET bottles, while temperature rise during pasteurization of canned ice tea provoked further migration of aluminum from the aluminum made lid. Storage temperature seems to correlate positively with aluminum migration. Colour intensity increased during storing. Ice tea stored at higher temperature (20 °C) had higher colour intensity (Tables 5 and 6) compared to 2 °C ($p < 0.0003$), which is in accordance with the observation of Rodrigues *et al.* (*12*). Lower storage temperature (2 °C) reduced slightly the increase of colour intensity in comparison to the storage at 20 °C (Table 5). In this study canned ice tea with peach-like taste had always higher colour intensity than pear-flavoured ice tea ($p < 0.001$). Canned peach flavoured ice tea had higher colour intensity than that in PET bottles ($p < 0.0053$). Additives of pear and peach ice tea are identical with the exception of aroma compounds, peach flavour containing lactones that are tipical peach aroma compounds. No correlation between iron content and colour intensity was found.

Table 4. Mass concentration (γ) of aluminium in ice tea with the taste of pear or peach packed in cans and stored at 2 and 20 °C; data represent means of 3 replicates ± σ

Time (days)	Pear 20 °C (mg/L)	Peach 20 °C (mg/L)	Pear 2 °C (mg/L)	Peach 2 °C (mg/L)
0	0.012 ± 0.003	0.012 ± 0.003	0.012 ± 0.003	0.012 ± 0.003
14	0.143 ± 0.003	0.156 ± 0.004	0.123 ± 0.005	0.147 ± 0.004
30	0.170 ± 0.003	0.176 ± 0.002	0.171 ± 0.005	0.156 ± 0.003
56	0.171 ± 0.002	0.145 ± 0.002	0.147 ± 0.006	0.177 ± 0.002
76	0.150 ± 0.004	0.167 ± 0.002	0.145 ± 0.002	0.124 ± 0.003
100	0.151 ± 0.003	0.179 ± 0.004	0.138 ± 0.004	0.120 ± 0.008

Table 5. Colour intensity (sum of absorbance at 420, 520 and 620 nm) of ice tea with the taste of pear or peach packed in cans or PET and stored at 20 °C

Time (days)	Can pear 20 °C	Can peach 20 °C	PET pear 20 °C	PET peach 20 °C
30	1.133	1.178	1.150	1.164
40	1.138	1.190	1.153	1.164
49	1.140	1.194	1.160	1.163
62	1.153	1.222	1.173	1.186
69	1.157	1.215	1.176	1.181
76	1.158	1.213	1.173	1.181
83	1.163	1.209	1.168	1.176
93	1.156	1.215	1.175	1.178
100	1.163	1.220	1.175	1.177

Table 6. Colour intensity (sum of absorbance at 420, 520 and 620 nm) of ice tea with the taste of pear or peach packed in cans or PET and stored at 2 °C

Time (days)	Can pear 2 °C	Can peach 2 °C	PET pear 2 °C	PET peach 2 °C
30	1.128	1.174	1.139	1.152
40	1.135	1.181	1.145	1.158
49	1.136	1.188	1.147	1.151
62	1.152	1.193	1.157	1.169
69	1.153	1.196	1.158	1.167
76	1.150	1.207	1.162	1.169
83	1.147	1.201	1.157	1.164
93	1.154	1.180	1.161	1.166
100	1.152	1.200	1.163	1.169

HMF content rose slightly during storage period in all samples (Tables 7 and 8). Peach-flavoured ice tea had higher HMF content than pear-flavoured ice tea from the very beginning and throughtout the storage period ($p < 0.0001$). Both types of canned ice tea had also higher HMF value than PET packed ice tea ($p < 0.0001$, Table 7) probably because of longer pasteurization. Ice tea in PET bottles underwent much shorter pasteurization though at higher temperature. HMF is an intermediate of browning reactions and is directly related to the degree of heating (*27*). HMF value correlated positively to the colour intensity index which is in agreement with other observations (*27,34*). Storage temperature correlated to HMF accumulation in canned peach-flavoured ice tea, but slightly less HMF accumulated in pear-flavoured ice tea (Table 8). Differences of HMF accumulation in ice tea stored at 2 °C and 20 °C were not statistically significant ($p = 0.6345$).

There is a big concern how to preserve the nutrients in beverages, particularly ascorbic acid. Ascorbic acid is also important as an antioxidant and plays an important role in preserving the colour in the products. Freshly prepared ice tea contained between 125–130 mg/L of ascorbic acid but its content decreased for about 30 % when ice tea was waiting for pasteurization (up to 24 h). Pasteurization caused a further decrease of ascorbic acid for about 30 %. Ascorbic acid degraded during storage at higher storage temperature (20 °C), in comparison to lower temperature (2 °C) with enhanced degradation rate (Tables 9 and 10). Degradation rate was higher in peach-flavoured ice tea than in pear-flavoured ice tea and it was higher in ice tea stored in PET bottles than in

Table 7. Mass concentration (γ) of HMF in ice tea with the taste of pear or peach packed in cans or PET during storing at 2 °C; data represent means of 3 replicates $\pm\sigma$

Time (days)	Can pear 2 °C (mg/L)	Can peach 2 °C (mg/L)	PET pear 2 °C (mg/L)	PET peach 2 °C (mg/L)
14	9.7 ± 0.7	15.0 ± 0.2	8.5 ± 0.1	9.3 ± 0.4
30	10.0 ± 1.1	15.5 ± 0.5	9.6 ± 0.1	10.6 ± 0.3
56	10.2 ± 0.2	15.3 ± 0.5	9.3 ± 0.3	10.5 ± 0.7
76	10.8 ± 1.0	16.0 ± 0.3	9.6 ± 0.3	10.7 ± 0.4
100	11.0 ± 0.4	15.8 ± 0.8	10.2 ± 0.5	10.8 ± 0.4

Table 8. Mass concentration (γ) of HMF in ice tea with the taste of pear or peach packed in cans or PET during storing at 20 °C; data represent means of 3 replicates $\pm\sigma$

Time (days)	Can pear 20 °C (mg/L)	Can peach 20 °C (mg/L)	PET pear 20 °C (mg/L)	PET peach 20 °C (mg/L)
14	9.3 ± 0.4	12.6 ± 0.2	7.2 ± 0.1	8.5 ± 0.8
30	10.7 ± 0.2	16.0 ± 0.3	9.5 ± 0.3	10.1 ± 0.1
56	10.7 ± 0.1	15.2 ± 0.7	9.2 ± 0.1	10.3 ± 0.3
76	10.7 ± 0.4	16.8 ± 0.4	10.0 ± 0.3	10.3 ± 0.3
100	10.9 ± 0.4	16.5 ± 0.8	9.5 ± 0.2	10.6 ± 0.1

Table 9. Mass concentration (γ) of ascorbic acid in ice tea with the taste of pear or peach packed in cans and stored at 2 and at 20 °C

Time (days)	Can pear 20 °C (mg/L)	Can peach 20 °C (mg/L)	Can pear 2 °C (mg/L)	Can peach 2 °C (mg/L)
0	127	124	127	124
BP*	86	76	86	76
AP*	68	59	68	59
7	48	31	46	33
21	12	5	23	14
49	<1	<1	27	8
69	<1	<1	<1	<1

BP* before pasteurization
AP* after pasteurization

Table 10. Mass concentration (γ) of ascorbic acid in ice tea with the taste of pear or peach packed in PET and stored at 2 and at 20 °C

Time (days)	PET pear 20 °C (mg/L)	PET peach 20 °C (mg/L)	PET pear 2 °C (mg/L)	PET peach 2 °C (mg/L)
0	127	124	127	124
BP*	86	76	86	76
AP*	68	59	68	59
7	5	1	4	3
21	1	<1	<1	<1
49	<1	<1	<1	<1
69	<1	<1	<1	<1

BP* before pasteurization
AP* after pasteurization

canned ice tea. This is in agreement with the observation of Moore *et al.* (*21*) who found better retention of ascorbic acid in orange juice stored in glass. Better retention of ascorbic acid was noticed in juice stored in glass bottles than in plastic film (*15,16*). The probable cause of higher degradation rate of ascorbic acid in glass could be attributed to light, while cans allow no light penetration. Ascorbic acid degradation is in relationship with flavour and colour changes *(13,14)*; in this case canned peach flavoured ice tea had the highest degradation rate of ascorbic acid and the highest colour intensity as well as the highest HMF content. Oxidation of ascorbic acid in solution is facilitated by ferric and cupric ions and accelerated by increased temperature. Juice acidity plays an important role in juice deterioration processes and correlates positively with furfural build up in orange and grapefruit juice (*35*). Ascorbic acid decomposes in furfural in acidic solutions (*36–38)* but no detectable levels of furfural were observed in neutralised orange juice (*39*). Ascorbic acid is thus a principal precursor of furfural. Since only reduced ascorbic acid was monitored in ice tea, there may be residual dehydroascorbic acid still present. Dehydroascorbic acid is a source of vitamin C and may play a certain role in nutritional value. In the animal body, the dehydroascorbic acid can be reduced to ascorbic acid by glutathione – glutathione reductase system. Ingested hedydroascorbic acid has a life time of only few minutes at human body temperature. Table 11 reveals the score of sensory evaluation carried out after 100 days of storage. Pear-flavoured ice tea got higher sensory evaluation score than peach-flavoured. A considerable loss of aroma compounds was greater in canned peach and pear-flavoured ice tea in comparison to ice tea stored in PET bottles. Canned ice tea is a subject of metal ions migration from packaging material into solution. Content of all three metals was perhaps too low to confer an offtaste, but they probably interfered with some aroma compounds of ice tea and changed its quality. PET stored ice tea got the highest score in sensory evaluation test although the differences were not statistically significant ($p = 0.066$). Lower storage temperature (2 °C) confers better score than higher storage temperature (20 °C). Temperature has the most important influence on the sensorial properties of ice tea, the differences between 2 and 20 °C are statistically significant ($p = 0.0064$). The differences between pear-flavoured and peach flavoured ice tea were not statistically significant ($p = 0.381$) although pear-flavoured ice tea got better score than the peach-flavoured. Sensory evaluation score thus correlated positively with the content of ascorbic acid.

Table 11. Sensory evaluation of ice tea stored at 2 and at 20 °C in PET or canned; data represent means of 5 panelists ± σ

Treatment	Peach	Treatment	Pear
	Points σ		Points σ
PET 20 °C	15.5 ± 1.8	PET 20 °C	16.9 ± 1.7
PET 2 °C	18.4 ± 1.1	PET 2 °C	18.1 ± 0.9
Can 2 °C	17.1 ± 2.0	Can 2 °C	17.7 ± 1.5
Can 20 °C	16.1 ± 1.7	Can 20 °C	15.8 ± 2.0

Storage temperature has the highest influence on the quality of ice tea. Lower storage temperature (2 °C) always confers better sensory evaluation score than higher storage temperature (20 °C). Packaging material plays an important role in the quality of ice tea. PET stored ice tea was generally better scored than canned ice tea. Aroma compounds seem to be involved in some deterioration processes during processing and storing of ice tea. Peach-flavoured ice tea had higher colour intensity index, HMF value and higher degradation rate of ascorbic acid. Possible cause could be some interactions of peach like aroma compounds with other constituents of ice tea during thermal treatment. Some other interactions of aroma compounds with traces of iron, tin and aluminum that migrated from packaging material may take place.

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Senzorska svojstva ledenoga čaja ovisno o pakovanju

Sažetak

Svrha je istraživanja bila odrediti promjene senzorskih svojstava ledenoga čaja (miris po breskvi i kruški) punjenog u boce od polietilentereftalata (PET) i limenke od bijelog lima s poklopcem od aluminija. Boce i limenke držane su pri 2 i 20 °C tijekom 12 tjedana. Tjedno su ispitivani kositar, željezo, aluminij, 5-hidroksimetil-2-furfuraldehid (HMF), askorbinska kiselina i intenzitet boje. Kao što se očekivalo, ledeni čaj u limenkama imao je veću koncentraciju kositra, željeza i aluminija zbog prodiranja iz ambalaže. Izgleda da na koncentraciju metalnih iona ne utječe vrijeme skladištenja već najviše kakvoća pojedine limenke. Koncentracija HMF-a, koja upućuje na intenzitet toplinske obradbe, povećava se tijekom skladištenja. HMF i intenzitet boje (tamnija boja) bili su u svim uzorcima veći u ledenome čaju u limenkama, a isto tako i pri višoj temperaturi skladištenja. Zadržavanje aromatskih spojeva bilo je bolje u ledenome čaju od krušaka i uvijek veće u čaju pakiranom u bocama od PET. Razina se askorbinske kiseline snizivala tijekom skladištenja s povišenjem temperature. Brže snizivanje uočeno je uvijek u ledenome čaju pakiranom u PET-bocama. Na osnovi senzorskih svojstava utvrđeno je da su potrošači bolje prihvatili ledeni čaj pakiran u PET-bocama nego onaj u limenkama.